We claim:

1. A method of selectively depositing a ferroelectric thin film on an indium-containing substrate in a ferroelectric device comprising:

preparing a silicon substrate;

depositing an indium-containing thin film on the substrate;

patterning the indium containing thin film;

annealing the structure;

selectively depositing a ferroelectric layer by MOCVD;

annealing the structure; and

completing the ferroelectric device.

2. The method of claim 1 wherein said preparing includes forming an oxide layer on the silicon substrate.

3. The method of claim 1 wherein said preparing includes forming a high-k oxide on the silicon substrate.

4. The method of claim 1 wherein said patterning includes etching the indium-containing thin film.

5. The method of claim 1 wherein said patterning the indium-containing thin film includes forming a silica dioxide trench structure.

6. The method of claim 1 wherein said depositing of an indium-containing thin film includes deposition of a In_2O_3 thin film, and which further includes depositing the In_2O_3 thin film on a substrate at a deposition temperature of between about 20°C to 300°C and a substrate temperatures of between about 20°C to 200°C; a chamber pressure of between about 1 torr to 10 torr; an oxygen partial pressure of between about 0% to 60%; a DC sputtering power of between about 200 W to 300 W, and a backward power less than 1%; and post-annealing at a temperature of between about 400°C to 800°C for between about 5 minutes to 60 minutes in an oxygen atmosphere.

7. The method of claim 1 wherein said selectively depositing a ferroelectric layer includes depositing a PGO layer includes preparing a PGO precursor of [$Pb(thd)_2$] and [$Ge(ETO)_4$], where thd is $C_{11}H_{19}O_2$ and ETO is OC_2H_5, having a molar ratio of between about 5 to 5.5:3, which is dissolved in a mixed solvent of butyl ether or tetrahydrofuran, isopropanol and tetraglyme in the molar ratio of about 8:2:1to form a precursor solution; wherein the precursor solution has a concentration of 0.1 M/L of PGO; injecting precursor solution into a vaporizer of the MOCVD reactor at a temperature of between about 150°C to 240°C at a rate of between about 0.02 ml/min to 0.2 ml/min to form a precursor gas; maintaining a precursor gas feed line at a temperature of between about 150°C to 245°C during MOCVD; maintaining the MOCVD reactor at a temperature of between about 500°C to 560°C; a pressure of between about 1 torr. to 10 torr.; an oxygen partial pressure of between about 30% - 50%; a vaporizer temperature of between about 200°C to 240°C; a precursor solution delivery rate of between about 0.1 ml/min- 0.2 ml/min; a deposition time of between about 1 hour to 3 hours; an annealing temperature of between about 500°C to 560°C; and an annealing time of between about 5 minutes to 30 minutes in an oxygen atmosphere.

8. The method of claim 6 wherein said selectively depositing a ferroelectric layer includes depositing a PGO layer which further includes preparing a PGO precursor of $[Pb(thd)_2]$ and $[Ge(ETO)_4]$, where thd is $C_{11}H_{19}O_2$ and ETO is OC_2H_5, having a molar ratio of between about 5 to 5.5:3, which is dissolved in a mixed solvent of butyl ether or tetrahydrofuran, isopropanol and tetraglyme in the molar ratio of about 8:2:1to form a precursor solution; wherein the precursor solution has a concentration of 0.1 M/L of PGO; injecting precursor solution into a vaporizer of the MOCVD reactor at a temperature of between about 150°C to 240°C at a rate of between about 0.02 ml/min to 0.2 ml/min to form a precursor gas; maintaining a precursor gas feed line at a temperature of between about 150°C to 245°C during MOCVD; forming the PGO layer in a first, nucleation step, using a deposition temperature of between about 500°C to 560°C for between about 5 minutes to 20 minutes; followed by a second, growth step which includes selective PGO deposition at a deposition temperature of between about 500°C to 560°C; a deposition reactor pressure of between about 1 torr. to 10 torr.; an oxygen partial pressure of between about 30% - 50%; a vaporizer temperature of between about 200°C to 240°C; a precursor solution delivery rate of between about 0.1 ml/min- 0.2 ml/min; a deposition time of between about 1 hour to 3 hours; annealing the PGO layer at an annealing temperature of between about 500°C to 560°C; and an annealing time of between about 5 minutes to 30 minutes in an oxygen atmosphere.

9. A method of selectively depositing a ferroelectric thin film on an indium-containing substrate in a ferroelectric device comprising:

preparing a silicon substrate;

depositing an In_2O_3 thin film on the substrate;

patterning the In_2O_3 thin film;

annealing the structure;

selectively depositing a PGO layer by MOCVD on the In_2O_3 thin film;

annealing the structure; and

completing the ferroelectric device.

10. The method of claim 9 wherein said preparing includes forming an oxide layer on the silicon substrate.

11. The method of claim 9 wherein said preparing includes forming a high-k oxide on the silicon substrate.

12. The method of claim 9 wherein said patterning includes etching the In_2O_3 thin film.

13. The method of claim 9 wherein said patterning the In_2O_3 thin film includes forming a silica dioxide trench structure.

14. The method of claim 9 wherein said depositing a In_2O_3 thin film includes depositing the thin film on a substrate at a deposition temperature of between about 20°C to 300°C and a substrate temperatures of between about 20°C to 200°C; a chamber pressure of between about 1 torr to 10 torr; an oxygen partial pressure of between about 0% to 60%; a DC sputtering power of between about 200 W to 300 W, and a backward power less than 1%; and post-annealing at a temperature of between about 400°C to 800°C for between about 5 minutes to 60 minutes in an oxygen atmosphere.

15. The method of claim 9 wherein said selectively depositing a PGO layer includes preparing a PGO precursor of $[Pb(thd)_2]$ and $[Ge(ETO)_4]$, where thd is $C_{11}H_{19}O_2$ and ETO is OC_2H_5, having a molar ratio of between about 5 to 5.5:3, which is dissolved in a mixed solvent of butyl ether or tetrahydrofuran, isopropanol and tetraglyme in the molar ratio of about 8:2:1to form a precursor solution; wherein the precursor solution has a concentration of 0.1 M/L of PGO; injecting precursor solution into a vaporizer of the MOCVD reactor at a temperature of between about 150°C to 240°C at a rate of between about 0.02 ml/min to 0.2 ml/min to form a precursor gas; maintaining a precursor gas feed line at a temperature of between about 150°C to 245°C during MOCVD; maintaining the MOCVD reactor at a temperature of between about 500°C to 560°C; a pressure of between about 1 torr. to 10 torr.; an oxygen partial pressure of between about 30% - 50%; a vaporizer temperature of between about 200°C to 240°C; a precursor solution delivery rate of between about 0.1 ml/min- 0.2 ml/min; a deposition time of between about 1 hour to 3 hours; an annealing temperature of between about 500°C to 560°C; and an annealing time of between about 5 minutes to 30 minutes in an oxygen atmosphere.

16. The method of claim 9 wherein said selectively depositing a PGO layer includes preparing a PGO precursor of $[Pb(thd)_2]$ and $[Ge(ETO)_4]$, where thd is $C_{11}H_{19}O_2$ and ETO is OC_2H_5, having a molar ratio of between about 5 to 5.5:3, which is dissolved in a mixed solvent of butyl ether or tetrahydrofuran, isopropanol and tetraglyme in the molar ratio of about 8:2:1to form a precursor solution; wherein the precursor solution has a concentration of 0.1 M/L of PGO; injecting precursor solution into a vaporizer of the MOCVD reactor at a temperature of between about 150°C to 240°C at a rate of between about 0.02 ml/min to 0.2 ml/min to form a precursor gas; maintaining a precursor gas feed line at a temperature of between about 150°C to 245°C during MOCVD; forming the PGO layer in a first, nucleation step, using a deposition temperature of between about 500°C to 560°C for between about 5 minutes to 20 minutes; followed by a second, growth step which includes selective PGO deposition at a deposition temperature of between about 500°C to 560°C; a deposition reactor pressure of between about 1 torr. to 10 torr.; an oxygen partial pressure of between about 30% - 50%; a vaporizer temperature of between about 200°C to 240°C; a precursor solution delivery rate of between about 0.1 ml/min- 0.2 ml/min; a deposition time of between about 1 hour to 3 hours; annealing the PGO layer at an annealing temperature of between about 500°C to 560°C; and an annealing time of between about 5 minutes to 30 minutes in an oxygen atmosphere.